SURFACE TAINT BUTTER

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INTRODUCTION

The recent occurrence of a flavour defect in pasteurized butter, and now commonly known to the trade as surface taint, made its appearance in 1919. This specific trouble first demonstrated itself in Canada on the Vancouver Market in a large consignment of first grade pasteurized butter. The affected butter was shipped from a reputable Alberta creamery. Since its appearance, this form of deterioration has occurred annually in all of the western provinces. While it has been found in Ontario and Quebec, its occurrence has been rather rare and unalarming. In the western provinces, however, its importance to the butter manufacturer has made the identification of the causative agents and the control of this form of spoilage an urgent problem.

REVIEW OF THE LITERATURE

There is little published data on what is now known as surface taint butter. This may be explained by the fact that it may be a new defect, but more likely, that it has appeared and been described under a different name or names. A specific butter trouble has been observed in Denmark, where it was first studied by Orla-Jensen(1), in which he states that butter affected by it rapidly acquired a peculiar putrid odour that ruined it for table use. It was found to be caused by bacteria.

Gilruth(2) of New Zealand in 1899 described a butter defect due to the presence of certain water bacteria. The butter developed a peculiar foetid odour when held at 65° F. for thirty-six hours.

From 1923 to 1927 studies of this flavour defect were made by Cordes(3) of the Blue Valley Creamery of Chicago. Macy(4) of the University of Minnesota studied in 1926 and 1927 this flavour defect as well. These two investigators working independently found butter with the surface taint defect to contain large numbers of bacteria and yeasts; the yeast count running as high as 500,000 to 1,000,000 per gram of butter. The conclusion reached by Macy was that the defect was due to the presence of a large coccus in associative action with certain types of yeast. Hunziker(5) in the 2nd edition of The Butter Industry, states that on the basis of our present knowledge the most effective means of preventing the appearance of this disastrous flavour defect are sanitation and cleanliness of all equipment used in manufacture and packing, accurate neutralization in the case of sour cream, efficient pasteurization, pure water for washing the butter and for rinsing of equipment, and the use of sterile parchment wrappers and liners.

The only published data on surface taint butter in Canada are that of Sadler (6). The summary of the results of his 1919-1923 investigation, carried out on samples of surface taint butter, and other material collected from the first troubled creamery, are as follows:—

(1) Certain samples of butter gave a bacterial count which is unusually high. The counts of seventeen churnings were 1,200,000, 1,200,000, 1,400,000, 2,000,000, 7,000,000, 146,000, 340,000, 213,000, 48,000, 11,000, 73,000, 168,000, 78,000, 2,000,000, 47,000, 140,000, 5,400,000 bacteria per gram respectively.

(2) The butter of at least two of the churnings contained too many bacteria of the coli type.

(3) The water from the storage tank was unfit for the usual purposes in the creamery.

(4) When the creamery amended its procedure with respect to the water supply, the deterioration of the butter ceased.

Conducting further bacteriological experimental work Sadler concludes—

As yet, the specific surface taint has not been observed. Whether or not other organisms with which we have not worked or combinations of these organisms will produce the taint which is the subject of this inquiry, has still to be determined.

Even so, it is to be seen that deterioration in butter, resulting from an inter-relation of the neutralizer with at least one bacterial strain, has been observed.

While the number of experimental churnings reported is small, the results are sufficiently encouraging to warrant a more extended inquiry into the soundness of the theory presented.

SOME PRACTICAL OPINIONS ON THE SUBJECT

Opinions of a number of manufacturers and graders were asked as to the probable cause of surface taint. They are summarized as follows:—

1. Poor sanitary conditions.
2. Poor water supply.
3. Dirty churns.
4. Dirty pounders, spades, etc.
5. Poor quality cream.
6. Old sweet cream.
7. Neutralization of cream at farm.
8. Low acid cream a factor.
9. Over neutralization of cream.
10. Improper methods of applying the neutralizer.
11. Kind of neutralizer used.
12. Never found in unneutralized sweet cream butter.
13. Sometimes found in unneutralized sweet cream butter.

From the foregoing data, it is evident that considerable diversity of opinion exists as to the probable cause of surface taint butter. It seems to be agreed by many that the cause or causes are of a bacteriological nature, while by others the cause or causes are of a chemical nature, with other evidence pointing to a possible combination of both.

A BRIEF DESCRIPTION OF THE DEFECT

Surface taint pasteurized butter may be detected by the experienced grader by both taste and smell. While graders associate a distinct flavour with this type of butter, the odour is most charcteristic and is extremely dependable in making a final diagnosis. Surface taint begins to appear about eight to ten days after manufacture, but the degree of development depends somewhat on previous storage temperatures; more rapid development taking place at temperatures around 40° to 45° F. When the suspected flavour is present, and the characteristic odour is not sufficiently pronounced to pass judgment, as so happens in many cases, graders now practice holding small samples of the butter in stoppered glass containers, thus exposing fresh cut surfaces, and named by Marker(7) surface taint. Butter so affected rapidly acquires in 24 to 48 hours at room temperature a peculiar characteristic foetid or putrid odour which is

easily recognized and so distinct as to cause no confusion with other undesirable butter flavours. Butter of this type is unfit for the trade.

THE EXTENT AND DISTRIBUTION OF SURFACE TAINT BUTTER

The seriousness of this butter defect, especially in the western provinces, is illustrated in the following figures obtained from the reports of federal graders in 1927:—

1. Number of samples of surface taint butter received from all provinces during 1927, May to November inclusive—124.
2. Provinces represented—Quebec, Ontario, Manitoba, Saskatchewan, and Alberta.
3. Distribution—

Province	Number of factories	Number of churnings
Quebec	1	1
Ontario	4	6
Manitoba	5	6
Saskatchewan	15	40
Alberta	26	71
Total	51	124

4. Frequency of occurrence—

In Alberta—	13	factories	had	each	1	churning	of S.T. butter.
	2	"	"		2	"	" "
	4	"	"		3	"	" "
	3	"	"		4	"	" "
	2	"	"		6	"	" "
	1	"	"		7	"	" "
	1	"	"		11	"	" "
In Saskatchewan—	7	"	"		1	"	" "
	3	"	"		2	"	" "
	1	"	"		3	"	" "
	1	"	"		4	"	" "
	1	"	"		5	"	" "
	1	"	"		7	"	" "
	1	"	"		8	"	" "
In Manitoba—	4	"	"		1	"	" "
	1	"	"		2	"	" "
In Ontario—	2	"	"		1	"	" "
	2	"	"		2	"	" "
In Quebec—	1	"	"		1	"	" "

INVESTIGATIONAL

Owing to the seriousness of the trouble and the increasing demand from manufacturers for information on the subject, an investigation of an experimental character was commenced in 1925. As material became available the work was carried on during 1925, 1926 and concluded in November 1927.

The investigation embraced a study of the following points.

I. Bacteriological.

(a) Numbers of yeasts, moulds and bacteria in surface taint butter.
(b) Types of bacteria in surface taint butter.
(c) Water in relation to manufacture of surface taint butter.

II. Chemical.

(a) Acidity of normal and surface taint butter.
(b) Curd content of surface taint butter.
(c) Kinds of neutralizers.
(d) Over neutralization.
(e) Brine concentration in relation to surface taint.

III. Experimental Manufacture of Surface Taint Butter.

(a) Methods of procedure.
(b) Scoring of butter.
(c) Results.

RESULTS

I. Bacteriological

(a) The Mould, Yeast and Bacterial Counts of Surface Taint Butter.

In Table I are given the mould, yeast and bacteria counts of 50 samples of surface taint butter. These samples were submitted by members of the Alberta, Manitoba, Ontario and Saskatchewan grading staffs during 1926.

TABLE I

Lab. No.	Date received	Moulds per c.c.	Yeasts per c.c.	Bacteria per c.c.	Liquifiers per c.c.	Province
1	June 15	1	*	18,000,000	1,160,000	Saskatchewan
2	" 18	0	*	37,000,000	1,600,000	Manitoba
3	" 19	22	*	6,800,000	250,000	Alberta
4	" 19	5	*	9,500,000	200,000	"
5	" 19	8	*	6,800,000	620,000	"
6	" 19	9	*	9,000,000	800,000	"
7	" 19	37	*	11,000,000	250,000	"
8	" 19	43	*	12,000,000	450,000	"
9	" 19	9	46,400	725,000	30,000	"
10	" 19	25	*	7,000,000	750,000	"
11	" 19	14	96,000	6,200,000	170,000	"
12	" 19	41	*	10,000,000	900,000	"
13	" 19	9	80,000	6,400,000	180,000	"
14	" 19	22	69,400	900,000	160,000	"
15	" 19	200	*	9,300,000	500,000	"
16	" 19	5	*	9,600,000	600	"
17	" 26	800	1,400	920,000	20,000	"
18	" 26	600	6,300	3,400,000	24,000	"
19	" 26	100	24,000	900,000	30,000	"
20	" 30	1	*	2,200,000	180,000	Ontario
21	" 30	3	3,200	320,000	4,000	"
22	July 6	11	*	250,000	1,700	"
23	" 9	3	26,800	90,000	2,500	"
24	" 10	3	*	.....	700,000	Manitoba
25	" 12	9	75,000	4,280,000	250,000	Saskatchewan
26	" 12	200	*	12,640,000	350,000	"
27	" 12	14	*	7,200,000	23,600	Manitoba
28	" 12	25	*	3,620,000	230,000	"
29	" 12	7,100	*	5,760,000	1,020,000	"
30	" 14	5	17,700	560,000	360,000	B.C
31	" 14	600	48,000	720,000	110,000	"
32	" 19	400	*	2,520,000	80,000	Manitoba
33	" 19	26,100	*	2,500,000	200,000	"
34	" 24	2	*	93,000,000	.....	Saskatchewan
35	" 26	1	57,200	3,440,000	Liq.	"
36	" 26	1	2,200	2,480,000	100,000	"
37	" 26	1	150	1,320,000	Liq.	"
38	" 26	2	30,800	2,220,000	"	"
39	" 26	Spreader	8,800	3,640,000	500,000	"

TABLE I—*Concluded*

Lab. No.	Date received	Moulds per c.c.	Yeasts per c.c.	Bacteria per c.c.	Liquifiers per c.c.	Province
40	" 26	1	40,000	2,290,000	1,000,000	Saskatchewan
41	" 26	6	3,000	2,140,000	140,000	"
42	" 26	400	*	11,000,000	200,000	"
43	" 26	4	9,700	560,000	80,000	"
44	Aug. 7	43	88,000	10,000,000	210,000	"
45	" 9	10,200	*	47,000,000	360,000	"
46	" 9	6	3,300	19,000,000	200,000	"
47	" 14	27	*	60,000,000	190,000	"
48	" 14	16	*	75,000,000	420,000	"
49	Sept. 10	4	40	16,000,000	10,000	"
50	Nov. 29	0	89,600	114,000,000	60,000	"

* Over 100,000 per c.c.

In Table II are given the mould, yeast and bacteria counts of 50 samples of surface taint butter submitted by the federal graders during 1927.

TABLE II

Lab. No.	Date received	Moulds per c.c.	Yeasts per c.c.	Bacteria per c.c.	Liquifiers per c.c.	Per cent Salt	Per cent Brine Conc.	Province
4	May 23	0	*	1,700,000	620,000	1·02	7·33	Alta.
8	June 10	2	*	1,840,000	130,000	1·67	9·67	"
27	" 29	2	88	35,000,000	50,000	1·44	8·25	"
38	Aug. 9	5	2,000	8,000,000	uncountable	1·94	10·52	"
40	" 6	2	98,400	30,000,000	170,000	2·06	12·00	"
52	" 18	3,330	*	31,000,000	950,000	2·25	12·33	"
55	" 22	5	*	7,000,000	110,000	1·61	9·09	"
57	" 23	0	14	1,200,000	30,000	1·87	11·78	"
59	" 29	1,900	*	7,000,000	1,600,000	0·57	3·78	"
64	" 31	3	2,100	2,160,000	60,000	1·76	10·89	"
67	Sept. 3	20,000	15,000	160,000,000	400,000	.....	.....	"
68	" 3	10,000	*	6,000,000	10,000	.....	.....	"
74	" 3	4,500	*	11,000,000	300,000	.....	.....	"
78	" 6	90	23,000	3,000,000	200,000	.....	.....	"
84	" 7	80	20,000	24,000,000	300,000	.....	.....	"
96	" 19	6,000	*	4,000,000	100,000	1·28	8·49	"
102	" 19	10,000	*	2,000,000	290,000	1·10	7·05	"
105	" 19	9,000	*	30,000,000	90,000	1·44	9·03	"
108	Oct. 1	7	*	1,170,000	100,000	1·36	8·32	"
116	" 20	2	28,300	58,000,000	1,200,000	1·29	7·92	"
120	" 25	7	*	3,500,000	100,000	1·24	7·85	"
122	" 25	21	*	3,120,000	80,000	1·04	6·73	"
1	May —.	51	82,000	1,930,000	9,300	1·40	8·96	Sask.
10	June 13	2	89	360,000	10,000	1·91	11·43	"
11	" 17	40	*	91,000,000	uncountable	1·20	7·32	"
20	" 21	25	*	25,000,000	"	0·74	4·37	"
21	" 24	126	*	76,000,000	500,000	0·90	6·04	"
22	" 27	6	64,800	36,000,000	uncountable	1·10	6·92	"
26	" 29	2	100	1,950,000	"	1·09	6·73	"
35	July 15	1	*	30,000 000	180,000	0·75	4·95	"
37	Aug. 1	32	*	39,000,000	uncountable	1·48	9·88	"
43	" 6	3	2,800	1,070,000	570,000	1·12	6·94	"
49	" 15	200	*	1,700,000	210,000	0·93	5·87	"
50	" 15	2,000	*	28,000,000	uncountable	0·81	5·19	"
54	" 18	1,200	7,300	19,000,000	140,000	1·48	8·61	"
79	Sept. 6	0	60,000	750,000	200,000	.....	.....	"
90	" 12	20	6,800	14,000,000	20,000	.....	.....	"
9	June 13	4	195	3,340,000	20,000	1·08	6·35	Man.
16	" 21	3	13,100	1,120,000	1,000	1·41	9·15	"
30	July 7	2	19,300	930,000	uncountable	1·41	8·64	"
31	" 8	0	68,000	25,000,000	"	0·98	7·16	"
32	" 14	200	*	150,000,000	"	0·98	6·54	"
45	Aug. 6	2	*	4,240,000	700,000	1·22	6·77	"
14	June 20	100	*	52,000,000	uncountable	unsalted	.....	Ont.

TABLE II—*Concluded*

Lab. No.	Date received	Moulds per c.c.	Yeasts per c.c.	Bacteria per c.c.	Liquifiers per c.c.	Per cent Salt	Per cent Brine Conc.	Province
15	" 20	0	*	123,000,000	uncountable	unsalted	.....	Ont.
29	July 4	0	191	620,000	1,200	2·67	15·37	"
89	Sept. 12	100	48,000	2,000,000	10,000	1·23	8·77	"
93	" 16	100	*	7,160,000	400,000	1·38	8·47	"
94	" 16	100	*	18,000,000	1,000,000	1·44	7·22	"
124	Nov. 12	39	72,500	61,000,000	750,000	1·50	8·67	Que.

* Over 100,000 yeasts.

From the above determinations of moulds, yeasts and bacteria it is quite evident that the counts of surface taint butter are exceedingly high through recontamination of the pasteurized cream and the butter during manufacture. Bearing in mind that butter which has been made from efficiently pasteurized and handled cream should not contain over a total of 30 moulds and yeasts per c.c. and 25,000 bacteria per c.c., much improvement must be forthcoming to meet this requirement.

Table III shows the analyses of eleven samples of surface taint from a troubled creamery in Alberta. Table IV shows a similarly troubled factory in Saskatchewan. Here again we find exceptionally high counts of bacteria, yeasts and moulds.

TABLE III

Surface Taint Samples From One Alberta Factory

Lab. No.	Date received	Moulds per c.c.	Yeasts per c.c.	Bacteria per c.c.	Liquifiers per c.c.	Per cent Salt	Per cent Brine Conc.
68	Sept. 3	10,000	*	6,000,000	10,000	.....	.....
95	" 19	5,000	*	18,000,000	150,000	1·16	7·26
96	" 19	6,000	*	4,000,000	100,000	1·28	8·49
97	" 19	5,000	*	1,500,000	150,000	1·42	8·70
98	" 19	8,000	*	1,000,000	220,000	1·20	7·64
99	" 19	6,000	*	1,000,000	140,000	1·29	7·69
100	" 19	900	*	1,000,000	70,000	1·50	9·62
101	" 19	7,000	*	1,000,000	120,000	1·17	7·33
102	" 19	10,000	*	2,000,000	290,000	1·10	7·05
103	" 19	20,000	*	1,500,000	110,000	1·00	6·57
104	" 19	10,000	*	4,000,000	uncountable	0·99	6·93

TABLE IV

Surface Taint Samples From One Saskatchewan Factory

Lab. No.	Date received	Moulds per c.c.	Yeasts per c.c.	Bacteria per c.c.	Liquifiers per c.c.	Per cent Salt	Per cent Brine Conc.
17	June 21	3,600	*	17,000,000	uncountable	0·77	4·85
18	" 21	1	13,600	42,000,000	500,000	1·69	10·12
19	" 21	1,300	*	21,000,000	950,000	0·82	5·32
20	" 21	2,500	*	25,000,000	uncountable	0·74	4·37
117	Oct. 24	1	7,700	3,760,000	70,000	1·07	6·79
118	" 24	2	57,600	9,280,000	320,000	1·04	6·25
119	" 24	1	11,200	4,850,000	200,000	1·22	7·71
123	Nov. 3	0	7,900	6,380,000	500,000	1·06	6·94

* Over 100,000 yeasts.

Table V gives a comparison of a factory troubled with surface taint and an efficiently operated creamery as judged by the mould, yeast and bacteria count of the finished butter.

TABLE V

Creamery A — Classification—Poor				Creamery B — Classification—Excellent			
Past. Butter Sample	Moulds per c.c.	Yeasts per c.c.	Bacteria per c.c.	Past. Butter Sample	Moulds per c.c.	Yeasts per c.c.	Bacteria per c.c.
1	22	6,700	4,000,000	1	2	13	7,700
2	30	3,600	5,400,000	2	1	18	7,900
3	50	9,300	6,000,000	3	0	16	3,200
4	16	7,000	4,160,000	4	2	15	4,400
5	20	1,900	2,580,000	5	0	28	3,800
6	10	26,000	1,160,000	6	0	7	800
7	200	100,000	7,600,000	7	0	4	12,300
Average	51	22,071	4,185,714	Average	·7	14	5,800

In comparing creameries A and B it will be noted that the total averages of moulds, yeasts and bacteria are excessively high in the troubled factory.

A Microbiological Comparison of Pasteurized and Unpasteurized Butter

To illustrate comparatively the difference between the yeast, mould and bacteria content of some of our so-called pasteurized and unpasteurized butter, the following counts are given in Table VI.

TABLE VI

Sample	Moulds per c.c.	Yeasts per c.c.	Bacteria per c.c.	—
1	23	20,000	27,600	Unpasteurized
2	92	200,000	5,380,000	"
3	50	500,000	810,000	"
4	47	25,000	1,610,000	"
5	120	100,000	4,060,000	"
6	60	70,000	250,000	Pasteurized
7	70	500,000	2,110,000	"
8	80	20,000	400,000	"
9	200	200,000	1,120,000	"
10	32	12,840	490,000	"

In comparing the above mould, yeast and bacteria counts of pasteurized and unpasteurized butter, it is at once evident that from a bacteriological standpoint, no appreciable difference appears in some samples of unpasteurized butter.

(b) Types of Bacteria in Surface Taint Butter.

While all surface taint butters examined show abnormally high total counts of bacteria, kinds as well as numbers must be taken into consideration. Referring to table I, under column "liquifiers per c.c.", we find high numbers of these types of bacteria. Bacteria of these types decompose the curd of the butter and in some cases attack the fats with the formation of disagreeable by-products. Keeping in mind that pasteurized butter should not contain over a total of

25,000 bacteria per c.c., liquifying bacteria alone in surface taint butters much exceed this standard.

(c) Water in Relation to Surface Taint Butter.

It is obvious that the water used for butter manufacture should be pure. It should be free from undesirable bacteria, moulds and yeasts as these organisms are known to be detrimental to the quality of butter. Bacteriological examination of some creamery water supplies in Western Canada where surface taint has occurred, show in most instances an impure supply. Manufacturers who have experienced outbreaks of surface taint, claim to have overcome the difficulty through a change in water supply, by chemical treatment or by pasteurization.

While bacteriological examination of well water supplies at certain creameries have revealed nothing abnormal, samples of water from holding tanks have been found to be highly contaminated. Wherever water intended for washing butter is stored in a tank reserved for this purpose, great care should be taken that the water is kept pure, and free from accumulation of organic matter. Storage tanks should be frequently emptied and thoroughly cleaned.

The fact should also be remembered that while a bacteriological examination of water may show only small numbers of undesirable bacteria, if allowed to enter the equipment, will rapidly multiply, unless effective methods of sterilization are in force, and very serious recontamination will occur.

II. Chemical

(a) Acidity of Normal and Surface Taint Butter.

Acidity determinations of fifty samples of surface taint and 50 samples of normal butter, by special chemical methods, have shown that many of the surface taint samples come within the same acidity range as that of normal butters. We might deduce from this that while acidity does not appear to be a primary factor, it may act secondarily, in that the flora which is present in the butter exhibits its activities when the conditions with regard to acidity harmonize with the requirements of the specific causative bacteria.

(b) Percentage of Curd in Normal and Surface Taint Butter.

Knowing that the incorporation of excess curd is a detriment because it causes rapid deterioration and injures the keeping quality of the butter, 20 samples of surface taint and 13 samples of normal butter were analyzed. A comparison is given in table VII.

TABLE VII

Sample No.	Normal Butter Per cent Curd	Surface Taint Butter Per cent Curd
1	0·931	0·837
2	1·269	1·266
3	0·917	0·978
4	0·844	0·712
5	0·927	0·805
6	1·017	1·223
7	1·027	1·429
8	1·174	1·022
9	1·119	1·095
10	1·128	1·215
11	1·287	1·146
12	1·234	0·982
13	1·026	1·019
14	.....	1·233
15	.....	1·317
16	.....	1·274
17	.....	0·888

TABLE VII—*Concluded*

Sample No.	Normal Butter Per cent Curd	Surface Taint Butter Per cent Curd
18		0·897
19		1·116
20		0·790
Average per cent curd	1·065	1·061

The above figures on surface taint compare closely with normal butter.

(c) Kinds of Neutralizers.

While the theory has been advanced that surface taint was caused by the use of specific neutralizers, this has not been borne out in practice or experimentally as the deterioration has resulted when hydrated lime, milk of magnesia and lime were used.

(d) Over Neutralization

Experimental work on over neutralization and careless methods of neutralization have failed to reproduce the defect.

(e) Salt in Relation to Surface Taint.

The preservative properties of salt are generally known and recognized. A concentrated solution of salt is capable of inhibiting the growth of most micro-organisms. Harrison(8) has shown that the organism which produces the red discolouration of cured codfish will grow in a medium containing 35.5 per cent of salt. Orla-Jensen(9) reports that all micro-organisms grow better and faster in unsalted butter than in salted butter and that the growth of water bacteria is retarded most by salt. Hunziker(5) states that a salt content below 2 per cent which is equivalent to a salt concentration of less than 13 per cent in the butter serum, is insufficient to check the growth of the majority of the micro-organisms present. A salt content of 2.5 per cent to 3 per cent which is equivalent to a salt concentration of approximately 16 per cent to 19 per cent in the butter serum, inhibits the growth of many bacteria and is especially helpful in retarding, if not preventing, mould growth. A salt concentration in excess of 3 per cent still allows the development of such flavour deteriorating species as the Coli-aerogenes group, B. subtilis and B. putrificus, and several moulds and yeasts that are more resistant to salt, and hence multiply in highly salted butter. As the percentage of salt found in surface taint butter corresponds fairly closely to the percentage found in normal pasteurized butter and that surface taint has occurred in butter with as high as 2.67 per cent salt, equal to a brine concentration of 15.37, the question of controlling these undesirable organisms by high salting is impracticable in view of the fact that the market for western butter demands on the average a butter of lower salt content than 2.67 per cent.

III. Experimental Manufacture of Surface Taint Butter

(a) Methods of Procedure.

Cream as required, showing varying degrees of acidity, was obtained from a local creamery. The acidity of the cream was determined by the usual procedure. The cream used in every case was sufficiently acid to warrant the use of a neutralizer. For neutralization, good quality commercial hydrated lime was used. In neutralizing, the procedure advised and the tables computed by Jones(10) were followed and used. The cream was pasteurized at 170° F. for ten minutes and then cooled to 50° F. On completion of cooling, inoculation

with the required strains of bacteria was proceeded with. Only bacteria isolated from water were used. All churnings were made in a hand churn. In all, thirty-four churnings of experimental butter were manufactured.

(b) Scoring of Butter.

The butters were graded by Jos. Burgess, Chief, Division of Dairy Produce, and W. F. Jones, Chief, Division of Dairy Manufactures.

(c) Results.

To illustrate, the grading results of seventeen experimental churnings are given in table VIII.

TABLE VIII

Churning No.	Date of Churning	Dates of Grading				
		Nov. 27	Dec. 1	Dec. 4	Dec. 6	Dec. 11
1	Nov. 24	1st grade	S.T.	S.T.	S.T.	S.T.
2	" 25	S.T.	S.T.	S.T.	S.T.	S.T.
3	" 26	S.T.	S.T.	S.T.	S.T.	S.T.
4	" 26	3rd grade	3rd grade	S.T.	S.T.	S.T.
5	" 24	1st grade	1st grade			
6	" 25	2nd grade	2nd grade			
7	" 26	2nd grade	2nd grade			
8	" 26	1st grade	1st grade			
9	" 26	2nd grade				S.T. ?
10	" 26	2nd grade				S.T.
11	Dec. 1					3rd grade
12	" 2			S.T.	S.T.	S.T.
16	" 1					S.T. ?
17	" 2			S.T.	S.T.	S.T.
18	" 3					3rd grade
19	" 3					2nd grade
20	" 3					3rd grade

S.T.—Surface Taint.

The cream used in experimental churnings 1, 2, 3, 4, 9, 10, 11, 12, 16, 17, and 18 was inoculated after pasteurization with liquifying water bacteria. Cream used in experimental churnings 5, 6, 7, and 8 contained no liquifying water bacteria. The cream used in churning 19 was inoculated with surface taint butter, and in churning 20, surface taint butter was lightly worked in. Of the eleven churnings made from inoculated cream, seven show positive surface taint and two doubtful.

SUMMARY

1. During 1927, 124 churnings were graded by federal graders as surface taint butter.
2. Butter which graded as surface taint was found in the provinces of Quebec, Ontario, Manitoba, Saskatchewan, and Alberta.
3. All surface taint butter analyzed during 1926 and 1927 were found to be abnormally high in yeast and bacterial content.
4. All samples were found to contain high numbers of bacteria, capable of decomposing butter curd.
5. Mould, yeast and bacteria counts of butter from troubled creameries have been found to be unusually high. In some factories, however, both low and high counts were recorded, indicating inconsistent sanitary control.
6. Many of the unpasteurized samples of butter examined were found to contain fewer bacteria than surface taint butter.
7. Some of the creamery well water supplies examined were found to contain high numbers of liquifying bacteria.

8. Storage tanks for water, through lack of systematic cleaning have been found to contribute large numbers of undesirable bacteria to the butter.
9. The acidity of many samples of surface taint butter tested were found to lie within the acid range of normal butters.
10. The curd content of surface taint butters examined corresponded closely to normal butters.
11. Surface taint has been found when lime, hydrated lime, and milk of magnesia were used for neutralizing.
12. Careless methods of neutralization and over neutralization failed to produce the defect.
13. Surface taint has occurred in butter with a salt content of 2.67 per cent equal to a brine concentration of 15.37 per cent.
14. While it is possible that a high salt content may assist in the control of surface taint, the method is impracticable owing to the market demands for a low salt butter.
15. Surface taint has been experimentally produced in butter made from cream pasteurized and neutralized and inoculated with certain strains of bacteria isolated from water. Similar creams not inoculated failed to produce the defect.

RECOMMENDATIONS

On the basis of our present scientific and practical knowledge, it would seem that the most effective means of preventing the appearance of surface taint are improved sanitary conditions within the plant as may be revealed through routine mould and yeast counts of the finished butter. Cleanliness, sterilization of all equipment used in manufacture and packing, accurate neutralization in the case of sour cream, efficient pasteurization, bacteriologically pure water for washing the butter and for rinsing the equipment, in other words, the adoption of every procedure and precaution which will prevent the entrance of undesirable micro-organisms in the manufacturing process, subsequent to efficient pasteurization.

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